theory, which requires that the squall wind be "produced by" the cirro-nimbus, just as also are the tornado (la trombe), the hail and the thunder storm. Our theory, based solely on observed facts and their direct interpretation, has the advantage of explaining why the squall wind develops without discontinuity throughout the length of the squall zone, even at those points where there does not exist any cloud, either cirro-nimbus or other kind.

5. *Guilbert* says (E, p. 559):

> The consideration of the squall zone is insufficient, for its trajectory is indeterminate, while the thunderstorm pursues a straight-line course. * * *

Durand-Gréville.—Numerous verifications long since proved to M. Durand-Gréville that all points on the squall zone, moving along with the depression of which they are a part, follow paths parallel with that of that depression. The clouds carried along by the squall wind when it reaches them, follow a similar course scarcely modified by the component added by the direction (W. or NW.) of the squall wind. The displacement of cloud masses under the action of the squall, scarcely exceeding some tens of kilometers, their trajectory is sensibly rectilinear. Durand-Gréville has not only constantly affirmed the fact of the rectilinear movement of thunderstorms *over short distances*, but has stated the same truth with reference to the tracks of discharges of rain or hail and of tornadoes (trombes). He early pointed out, further, that this path is almost parallel with that of the low center, having a similar direction and a speed equal to that of the center. He thus has shown that, far from being indefinite, the advance of the squall zone and of all its attendant phenomena is absolute in form, in orientation, in direction, and in velocity.

A BREATHING WELL.

Under date of November 29, 1915, Mr. John Free, of New Carlisle, Ohio, sent the following account to the Weather Bureau office in Columbus, Ohio:

> I have a well that puzzles our mind. It will blow out air and also take in air at different times. I have noticed this for two years. When it blows out it is an indication of rising temperature, wind, and rain. When it takes in air it denotes fair weather and falling temperature. The well is covered with cement and has a wooden pump. At the side of the pump we left a space of 14 by 4 inches for the frost pin to work back and forth. So we put a block in the space to keep the mice out, and when it blew out it sounded like steam escaping. So I thought it would blow a 10-cent horn. So I bored a hole in a block and placed the horn in the hole and it did blow. I have heard it blow for 48 hours without ceasing; and also saw it take in air for just as long. On the 26th [November, 1915?] it blew air out and it rained. On the morning of the 27th it was taking in air all day. On the next morning (28th) it blew out very strong. At 3 p. m. it was raining.
> Can you explain that; did you ever see or hear of the like?

In his reply, Prof. J. Warren Smith points out that this "breathing" of wells and caves is well known to many students, although it must often escape the attention of persons less keen than our correspondent. As the reply pointed out, the phenomenon is causally related to the escape of fire damp and other gases in mines, to the variations in the flow of springs, the roiling of well water,[1] etc.

A storm center, or area of low pressure, is preceded by a region of falling atmospheric pressure, and while a locality is under the influence of this region of rapidly falling pressure the air and other gases within the earth's crust are partially released from the pressure confining them. They then tend to escape through the crevices and at the same time may press outward the waters feeding springs and wells. Thus the water in wells tends to rise, springs to flow copiously, mines and caverns to give forth air and gases during the falling pressure which precedes and accompanies the bad weather of storm centers.

Behind a storm the atmospheric pressure is increasing, thus just reversing the above processes; and under the action of the more pronounced high-pressure areas air may perhaps be even pressed into the earth's crevices. Thus the clearing and (in winter) cooling weather that precedes and accompanies anticyclonic areas would be announced by an inbreathing of such a tightly covered well as the one described above.—C. A., jr.

[1] See "Wells and storms," this REVIEW, July, 1900, 28: 293.

A TEMPERATURE INVERSION IN THE GRAND RIVER VALLEY, COLORADO.

By E. S. NICHOLS, Local Forecaster.

[Dated: Weather Bureau, Grand Junction, Colo., Dec. 9, 1915.]

In the Grand Valley of western Colorado on the morning of January 7, 1913, occurred so remarkable an inversion of temperature that special attention should be called to it.

The main portion of the Grand Valley is a southward and southwestward sloping plain on the northern side of the Grand River, and extending from the foothills of Grand Mesa 50 miles or more to the Utah line and beyond. The Weather Bureau maintains several cooperative stations in the southeastern or upper half of the valley, in addition to the regular station at Grand Junction which is about 12 miles from the upper end. All the stations referred to are equipped with Weather Bureau pattern maximum and minimum thermometers, which are exposed in instrument shelters of Weather Bureau design. At the cooperative stations the thermometers are about 5 feet above ground; while at the Weather Bureau office in Grand Junction they were, on the date in question, at a height of 44 feet above ground. The relative positions of the stations are shown in figure 1, which also gives elevations above sea level, closely approximated when not known exactly, of those that reported for the date mentioned.

In general, in this upper half of the valley, the ground slopes to the river banks on the north side of the Grand, while on the south side of that stream low bluffs rise from the water's edge or a short distance therefrom. Back of the bluffs in the upper fourth of the valley the ground is in general a nearly level bench or terrace known as "Orchard Mesa," except in the extreme upper end of the valley where the ground is at first rolling but soon merges into the foothills of Grand Mesa.

On the morning of January 6, 1913, the weather map showed the northern side of a low-pressure area over southwestern New Mexico; while high-pressure centers with maximum sea-level barometer readings above 30.6 inches and 30.8 inches, respectively, overlay the Snake River Valley and the east-central portions of the Dakotas. At Grand Junction that morning the sky was cloudless, temperature reached -6°F., dew point was -9°, and the southerly wind was light; temperature rose to a maximum of 11° during the day, which was practically cloudless and had 100 per cent of the possible sunshine.

On the morning of the 7th the southwestern disturbance had disappeared and the western peak of high pressure, with a central barometer reading above 30.6 inches, overlay the Plateau region. The sky was again cloudless at Grand Junction, the temperature there fell to −19°F., the dew point was −23°, and the wind blew at the rate of 6 miles per hour from the southeast. As the district, during the preceding night, had been within the Plateau-region high, and as the atmosphere was clear and dry and, in its lower strata at least, quiescent, conditions were favorable to the setting up of strong temperature inversion.

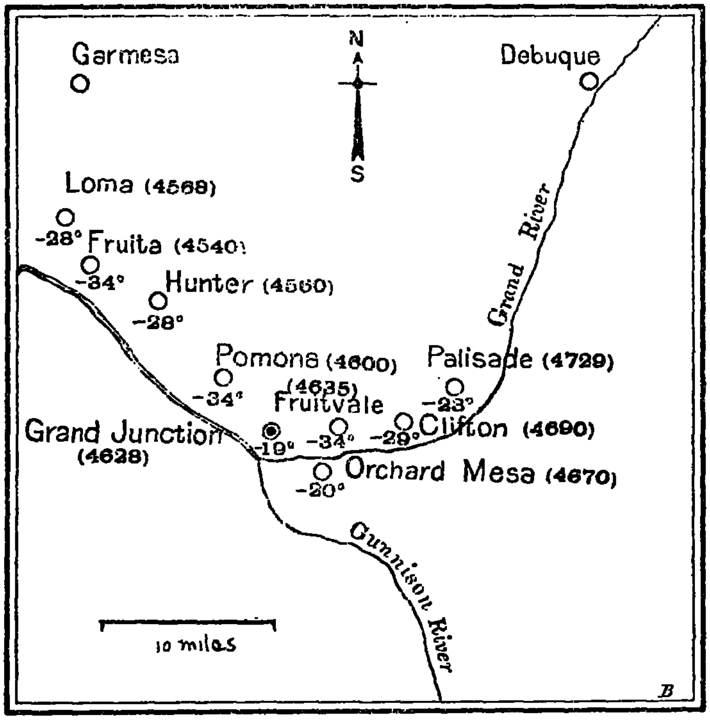

FIG. 1.—Minimum temperatures at Grand Valley stations, Grand Junction fruit district, western Colorado, January 7, 1913. (Figures in curves give altitudes in feet above sea level; temperatures in °F.)

TABLE 1.—*Minimum temperatures recorded at Grand Valley stations, western Colorado, morning of Jan. 7, 1913.*

Stations.	Elevations.	Minimum temperatures.
	Feet.	*°F.*
Palisade	4,729	−23
Clifton	4,690	−29
Fruitvale	4,635	−34
Pomona	4,600	−34
Loma	4,568	−28
Hunter	4,560	−28
Fruita	4,540	−34
Orchard Mesa	4,670	−20
Grand Junction (Weather Bureau)	4,628	−19

Table 1 gives the minimum temperatures recorded at the valley stations, which are arranged in order of descending elevations, except in the cases of the Weather Bureau office and the Orchard Mesa substation. These temperatures have been entered on the outline map of figure 1. Evidently the coldest air tended to accumulate close to the ground in the middle and lower parts of the district on the north side of the Grand River. This is shown by the following conditions:

1. The highest substation reading, −20°F., was taken on Orchard Mesa, the cold air from which was evidently carried, by the southeast wind that prevailed that morning, over the bluffs lying along the river on the north side of the mesa.

2. The highest substation reading on the north side of the river was −23° at Palisade in the upper end of the valley. Clifton, the next station down, reported −29°. Fruitvale, Pomona, and Fruita, still lower down, had the lowest readings, −34°.

3. The highest reading of all, −19°, was taken at the Weather Bureau office in the central part of the district but at the greatest elevation above ground.

Hunter and Loma, in the lower section, reported −28°, but this is undoubtedly higher than would have been observed in the lowlands near by. These stations are located on slight elevations in a somewhat rolling section. The same is true of the Fruita station to a less degree. Also, the office reading was unquestionably somewhat higher than would have been observed in the free air at the same elevation, on account of the influence of the office building and surrounding structures.

Assuming that the temperature in Grand Junction at a height of 5 feet above ground was −34°, the same as at Fruitvale and Pomona, above and below Grand Junction, respectively, and allowing 2° for the influence of the office building, we have a difference of 13° due to a difference in elevation of 39 feet.

Again, assuming that the temperature over that part of the valley lying on the north side of the Grand River opposite Orchard Mesa was, at the elevation of the top of the bluff on the south side of the river, the same as on Orchard Mesa, we may ascribe the difference between the Fruitvale and Orchard Mesa readings to difference in elevation. This elevation difference is not known exactly, but it is approximately 35 feet. Then we have a difference of 14° due to a 35-foot difference in elevation.

It may be noted in this connection that −19° is the lowest temperature on record at the Grand Junction office, not only for the period since the establishment of the regular station on January 1, 1899, but for the entire period of observation since records were begun by the cooperative observer in 1892. The effect of the extreme cold upon fruit trees, not only in the middle and lower portions of the Grand Valley, but also in other fruit districts of western Colorado, was, in places, serious. In places peach trees and young apple trees were killed outright. In other cases young wood on old apple trees and peach trees was killed, trunks of large apple trees were split open, and the wood of trunks and branches of large peach trees was badly discolored. A large percentage of the affected trees have since apparently recovered completely.

RELATION BETWEEN METEOROLOGICAL CONDITIONS IN THE NETHERLANDS AND SOME CIRCUMJACENT PLACES.[1]

By J. P. VAN DER STOK.

[*Reprinted from* Science Abstracts, Sec. A, Nov. 25, 1915, §§ 1494–1495.]

Atmospheric Pressure.

The methods of correlation are employed to ascertain to what extent deviations of pressure from the normal in Holland may be determined from the simultaneous deviations from the normal at certain surrounding stations. For reasons which are set forth, the three winter months December to February only are dealt with. In the first part of the inquiry 10-day means of pressure published by the "Deutsche Seewarte" are employed. Pressure variations at the Helder are correlated with those at Valencia (Ireland), Clermont, Milan, Neufahrwasser, and Christiansund. The partial correlation coefficients are worked out, and it is found that Clermont exercises the

[1] *See* Proc. K. Akad. Amsterdam, Sept. 8, 1915, 18: 310–327.